"STUDY ON REMOVAL OF HARDNESS FROM GROUNDWATER USING LOW-COST ADSORBENT"

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Abstract - *This study examined potential and design parameters of adsorption study to remove hardness of natural and synthetic water samples by using Amorphophallus Campanulatus adsorbent (ACA). The initial concentration of hardness of both real ground water and synthetic water samples are 710mg/l and 1610mg/l respectively. Those samples are treated with 5 different dosages of amorphophallus campanulatus adsorbent. To study the removal efficiency of adsorbent, the batch and column studies are carried out. In batch study experiments with varying concentrations of adsorbent dose vs different contact time is analysed to know the removal and optimum dose of adsorbent with contact time and to determine maximum removal efficiency. In column study, column is set to remove the hardness and determine the maximum removal efficiency is carried out by using fixed bed column of diameter 3.5cm and depth of 32cm are used for a flow rate of 1, 1.5, 2, 2.5, 8, 25 and 30ml/min. By the study the experiments demonstrate that amorphophallus campanulatus adsorbent remove the hardness efficiency of 83.09% for real ground water and 85.15% for synthetic water in batch study for a dosage of 10g/l at a contact time of 0.5 hr. In column study 92.95% for real ground water, 93.16% for synthetic water. From the kinetics models it is determined that 46.76g adsorbent for real ground water and 59.9g for synthetic water is required for the treatment of hardness using Langmuir Isotherm and 13.03g adsorbent for real water and 18.05g for synthetic water using Freundlich Isotherm but the R2 value is near to 1 for the Amorphophallus Campanulatus adsorbent therefore it follows the Freundlich Isotherm which indicates the adsorbent follows double layer theory.*

Key Words: **Amorphophallus campanulatus adsorbent(ACA)**

1. INTRODUCTION

The groundwater is in chemical equilibrium as a result of its prolonged residence period in the subsurface. Prior to being pumped out of the ground or flowing into surface water, groundwater typically stays in the subsoil for many years. When groundwater is pumped up or dumped into surface water, it comes into touch with the atmosphere. When water is heated, the equilibrium changes, causing calcium carbonate to precipitate as a result of the Ca^{2+} and HCO_3^- ions ($CaCO_3$). Due to calcium carbonate scaling, particularly high concentrations of Ca^{2+} and HCO_3^- ions can pose problems for the consumers (e.g., deposits in water boilers). Drinking water businesses partially remove calcium ions from the water to prevent calcium carbonate precipitation at the consumers taps. Softening is the term for this. The lime soda water softening method is one of the first chemical techniques in the water filtering process used to lower the hardness of ground water.

1.1 Study area

The Hassan district in the Indian state of Karnataka contains the city and taluka of Arsikere. In the Hassan district, it is one of the bigger cities. There are 31 wards in the municipal council for Arsikere city. This area, also known as Kalpataru Nadu, is well-known for producing coconuts. The taluk headquarters are located at Arsikere, a significant railway junction on the South Western Railway that connects North Karnataka with Mangalore and Mysore and serves as a hub for visitors travelling to adjacent locations without rail access including Belur, Halebidu, and Shravanabelagola. 7 miles away is Harnahalli Kodimata. One of the Hoysala princesses who constructed a lake (kere in Kannada) close to the town is the source of the name Arasikere. Kannada for "queen" is arasi. Therefore, it is 'Arasiya+kere' which means "queen's pond". Arasikere was also called Udbhava Sarvajna Vijaya and Ballalapura at various times.

1.2 Preparation of adsorbent

Amorphophallus campanulatus is chopped into little pieces using knife. Then placed in the sun to dry for 2-3 days, after blending to powdered using mixer. Then powder was placed at 550°C in a muffle furnace for 5 hours to covert the powder to ash. The prepared ash is used as an adsorbent to remove the hardness.

2. METHODOLOGY

The study was carried out by identification of the different location through the collection of water samples and analysis for several area. To remove the hardness in ground water, an adsorbent is prepared using Amorphophallus campanulatus.

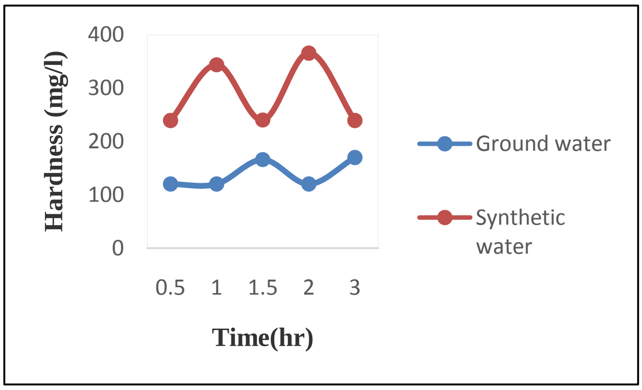
By the results obtained though the analysis the maximum concentration of hardness is selected for study area. The batch study and column study are carried out to determine the optimum dose and time duration for both solidified and crystallinity adsorbent.

Table -1: Efficiency in batch study and column study using crystallinity adsorbent

Parameters	Raw ground water	After treatment using Batch study	After treatment using Column study	Efficiency in Batch study (%)	Efficiency in Column study (%)	IS 10500
	For ground water					
pH	7.5	7.2	6.9	4	8	6.5-8.5
Alkalinity (mg/l)	87	81	72	6.89	17.24	30-500
Total Hardness (mg/l)	710	120	50	83.09	92.95	200-600
Chloride (mg/l)	295	283	263	4.06	10.84	250-1000
	For synthetic water					
Total Hardness (mg/l)	1610	239	110	85.15	93.167	-

The initial concentration of ground water hardness was 710 mg/l found to be; after treatment, it had a hardness of 120 mg/l by using batch study and 50mg/l using column study. The efficiency of removing hardness was 83.09% using batch using and 92.95% in column study. Initially synthetic water had a hardness of 1610 mg/l in the beginning; after treatment, it had a hardness of 239 mg/l by using batch study and 110mg/l using column study. The efficiency of removing hardness was 85.15% using batch using and 93.167% in column study.

Chart -1: Optimum contact time for hardness removal using crystallinity adsorbent



This is because more voids spaces of adsorption sites are available in the beginning, but as time goes on, the increased repulsive forces between multivalent metallic cations like calcium and magnesium ions in the solid and liquid phases make it more difficult to add more adsorption to the remaining void surface sites.

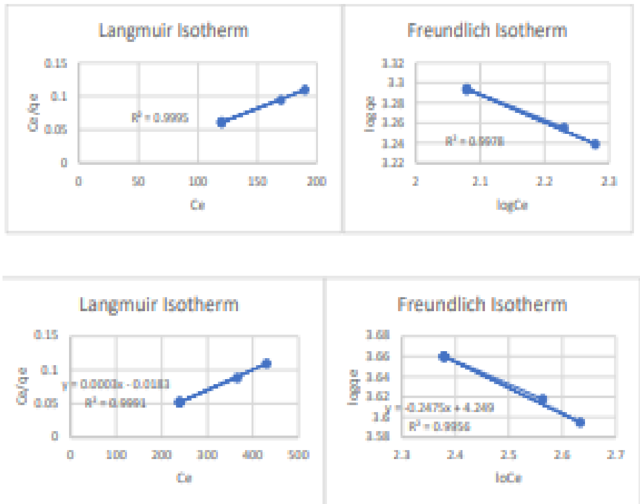


Fig -1: Langmuir Isotherm and Freundlich Isotherm for real ground water and synthetic water

From the kinetics models, it is calculated that per litre it requires 46.76g adsorbent for real ground water and 54.9g for synthetic water which belongs to Langmuir isotherm and from Freundlich isotherm it is determined that 13.03g adsorbent for real ground water and 18.05g for synthetic water. From the graph the R^2 value is near to 1 by the Amorphophallus campanulatus adsorbent. Therefore, it follows Freundlich isotherm which indicates the adsorbent follows double layer theory.

3. CONCLUSIONS

• The analysis of the physico-chemical characteristics revealed that the total hardness exceeds the permitted regulatory limit.

• On the addition of Amorphophallus campanulatus adsorbent to water sample, no significant fluctuation was seen in pH, alkalinity, chloride parameters.

• Hardness removal efficiency of 83.09% was achieved in batch study using crystallinity Amorphophallus campanulatus adsorbent for ground water at a contact time of 0.5 hour for the optimum dosage 10g/l.

• Hardness removal efficiency of 85.15% was achieved in batch study using crystallinity Amorphophallus campanulatus adsorbent for synthetic water at a contact time of 0.5 hour for the optimum dosage 10g/l.

• Hardness removal efficiency of 92.95% was achieved in column study using crystallinity Amorphophallus campanulatus adsorbent for a varied flow rate of real ground water.

• Hardness removal efficiency of 93.16% was achieved in column study using crystallinity Amorphophallus campanulatus adsorbent for a varied flow rate of synthetic water.

• Crystallinity Amorphophallus campanulatus adsorbent can effectively be utilised as adsorbent for removal of hardness in water samples and it is freely abundant available in nature it can be consider as a low-cost adsorbent.

• From the kinetics models, it is calculated that per litre it requires 46.76g adsorbent for real ground water and 54.9g for synthetic water which belongs to Langmuir isotherm and from Freundlich isotherm it is determined that 13.03g adsorbent for real ground water and 18.05g for synthetic water.

• From the graph the R 2 value is near to 1 by the Amorphophallus campanulatus adsorbent. Therefore, it follows Freundlich isotherm which indicates the adsorbent follows double layer theory.

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